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SEALING ~~JOINT~~ WITH PLATE-LIKE INTERNAL STRUCTURE FOR VERY HIGH TEMPERATURES

The invention considers a sealing joint with plate-like internal structure for very high temperature applications, typically from 600 to 1,000°C.

In the field of static sealing of pipe flanges or similar assemblies, likely to be subject to pressure or temperature shocks, we commonly use metallic spring joints which, associated with the tightening of metal flanges onto metal, provide a proper seal as well as a high resistance to stresses exercised through pressure, dilatation or from external forces.

These joints work via constant compressing set by the depth of the housing, or the thickness of a distance ring, fitted between the seating faces of the flanges. They comprise an internal elastic core which generates the counteracting force needed for sealing, and a continuous casing pushing against the flanges and which creates the seal. The elastic elements most commonly used in this field are open or closed tubes, coil springs with joined spires or even different profiles in the shape of a C, U or E.

The core is to preserve the strain through the passing of time under specific mechanical and thermal constraints. Its elastic properties often determine the state of the joint and its service life. Indeed, due to the constant compressing of the joint, it tends to slacken off through time, thereby producing an ever weaker tightening stress. This phenomenon will be amplified under high temperatures.

The slackening can be reduced by limiting the mechanical constraints on the core of the joint by means of dividing the internal structure into several elements each of which being under less constraint. Some examples are given in the patents US A 4 901 987 and 5 639 074. They consist in non-sagging springs wound in coils. The contact between the successive layers of coils generates the stiffness of the spring. However, the final embodiment of these prior springs does not generate sufficient stiffness for the applications that we are considering due to the continuous nature of the coil, and which, moreover, were not designed for sealing applications. The principal objective of the invention is therefore to constitute a sealing joint with an internal elastic element that can preserve its elastic properties under temperatures of between 600 and 1,000°C over a sufficient service life. A proper elastic stiffness of the joint is accompanied with a good distribution of the forces over its entire structure.

For this reason, the joint in question associates an external metallic casing with an internal elastic structure composed of an assembly of strips brought into contact with each other via staggered supports and sagging under the overall compressing of the joint.

Contrary to what we have seen in the aforementioned patents, the elastic element is composed of separated and overlaid strips which, due to the circular properties of the joint, are folded back on themselves and therefore have individual stiffness

greater than that of the spires creating a single strip.

Several specific embodiments of the invention are shown in the drawings:

- drawings 1a and 1b represent two alternatives of a single embodiment of the invention;

- drawing 1c represents the operating mode;

- drawing 1d illustrates a specific element of the joint;

- drawing 1e illustrates a top and cross section view of the joint;

- drawings 2a, 2b, 2c, 2d and 2e illustrate various types of suitable strips.

The first embodiment is represented in drawing 1a; it is composed of a metallic casing 1 with, on the exterior of two supporting surfaces 2 and 3 designed to create a seal between two flanges 4 and 5, projections 6 whose edges touch the flanges 4 and 5 so as to focus the tightening stress. It is also composed of an internal structure 7 made of several flexible spring plates 8 pushing against intermediary blocks 9 which separate them.

The core of the joint is therefore composed of alternate layers of strips 8 and blocks 9 in a vertical plane extending from one of the flanges 4 to the other 5. The blocks 9 create a staggered network, being laid out in vertical rows in which they occupy every other space between the strips 8. If we scan the joint in a normal plane with the axis of symmetry of the entire joint, horizontal and vertical to the flanges 4 and 5

between two strips 8, we similarly discover a block 9 every second vertical row that is crossed.

The joint in drawing 1a has a structure known as radial, where the blocks 9 are concentric rings with different radii. To maximise the tightening stress, the rows, that being three in the drawing, where the blocks 9 touch the outer strips 8, their other surface pushing against the support surfaces 2 and 3, will have the same diameter as the projections 6 so as to extend under them, and the other rows of blocks 9 extending half way between the projections 6. The two outer strips 8 touch the metallic casing 1. This contact has a smooth flat link.

Depending on the rigidity of the two outer strips 8, which notably have the role of distributing the counteracting force of the strip structure over the metallic casing 1, the blocks can have other positions.

The joint can also have a structure known as ortho-radial, where the blocks 9′ radiate, as illustrated in drawing 1b. Seen from a horizontal cross section through the joint the blocks are still staggered and similar to that in drawing 1a.

The operating of the two structures is substantially the same. The compressing of the joint results in alternating sagging of the strips 8 between the offset blocks 9 or 9′. The strips 8 distort as far as coming into mutual contact with the pairs of blocks 9 or 9′, as in drawing 1c which shows the absence of space between the strips 8 alternating with the blocks 9 in each of the vertical rows. This joint core whose stiffness varies depending on the distance between the

blocks guarantees good preservation of the tightening stress due to the stress of the strips below their elastic limit at high temperature which does not engender any sagging of the material.

The strip material is to be chosen in accordance with the temperature encountered and the elastic limit. We advise using nickel based super-alloys, alloys with oxide dispersions or ceramics due to the low distortion levels the strips 8 are subject to. The blocks 9 or 9' can be made in the same material. Finally, the material used for the external casing 1 will also be chosen to resist temperatures and according to the type of fluid to be made seal proof. Nickel or iron based alloys can be used due to the capacity to create a layer of oxide which prevents corrosion at high temperatures.

A precise embodiment of the invention can comprise three projections 6 over each of the supporting surfaces 2 and 3 and eight flexible strips 8. The blocks 9 can be composed of circular section wire. The internal structure can be made according to numerous variations which will depend on cost and technical factors in line with the sectional dimensions of the joint or its nominal diameter. The choice of radial or ortho-radial structures will depend on the dimensional and mechanical criteria according to the permitted constraints of the materials being used.

In every case, the blocks 9 or 9' of a single layer can be jointed together by connecting strips. In the case of an ortho-radial structure, these connecting strips consist of two rings or a single ring 10

extending along the side of the strips 8 and joining them, as represented in drawing 1d.

This drawing, and all the more so drawing 1e, gives the opportunity to assert some of the general aspects of the joint: it is overall circular about a hole 12 made through the flanges 4 and 5; the casing 1 has a U-shaped section closed towards the inside of the circle and the hole 12 but open towards the exterior; the strips 8 are circular with a closed outline, which endows them with good stiffness against distortions through sagging; they are also distinct from each other, being perfectly flat and with a uniform surface in the uncompressed state of the joint; the projections 6 are linear and more precisely circular, and extend around the hole 12; even though this has not been represented, we understand that the blocks 9 of the radial structure in drawing 1a will be in the same position as the projections 6 in a similar representation to drawing 1e.

A few more embodiments of the invention will be described below.

Drawing 2a shows a cross section of a metallic strip 8a whose supports 9a are not formed by the separated blocks but by folds close to the strip itself. This alternative can be equally radial or ortho-radial.

Drawing 2b shows a cross section of a ceramic strip 8b whose supports 9b are formed by ceramic blocks but bonded to the strip. This alternative appears to be appropriate to the ortho-radial structure.

The overlaying of the strips represented in drawings 2a, 2b and 2c is formed by contacts between the offset supports (folds, ceramic blocks, cord of solder) between the two successive strips.

Drawing 2c shows a cross section view of a metallic strip 8c whose supports 9c are formed by fillings such as cords of solder deposited by a welding apparatus at regular intervals. This alternative can be equally used for radial or ortho-radial structures.

The overlaying of strips represented in drawings 2a, 2b and 2c is formed by contacts between the offset supports (folds, ceramic blocks, cord of solder) between two successive strips.

Drawing 2d shows a cross section view of a corrugated metallic strip 8d that works in a similar manner to the above strips but allows for additional assemblies via multiple combining so as to vary the stiffness, as shown in drawing 2e which illustrates an assembly of strips 8d in pairs. This corrugated structure can also be used for ortho-radial or radial structures, as long as the waves are circular or radial. In this type of embodiment, the supports 9d are formed by contacts between the facing ridges of the waves of neighbouring strips. Although the distortion of the strips 8d is different to that in the previous embodiments, as they flatten out under the stress instead of warping, the operating of the joint will be the same for such an embodiment. Care is to be taken so as to avoid the strips 8d from slipping at a tangent. They can then be attached together onto the supports via welds 11, rivets, etc.